

with the above testing procedures. The manufacturer shall provide a type D certification for the reflective sheeting with each shipment of delineator units.

- (e) **Prequalification.** Prior to the installation of flexible delineator posts, the Contractor shall have demonstrated to the satisfaction of the Department of Transportation that the posts to be provided shall meet the physical and performance requirements of this Specification.

SECTION 711

TRAFFIC STRIPE

Description. This Section establishes the requirements for materials and tests for thermoplastic compounds, preformed plastic tapes, traffic stripe paint, and glass beads.

711.01. THERMOPLASTIC COMPOUNDS.

Hot Applied Thermoplastic Compound Materials. The hot applied thermoplastic compound shall meet the requirements of AASHTO M 249. The binder component shown in Section 4.2, Table 1 Composition, shall be made of hydrocarbon material unless otherwise specified on the Plans. Each shipment of the product shall be accompanied by a type A certification as specified in Subsection 106.04.

711.02. PERMANENT PAVEMENT MARKING TAPE.

General. The plastic striping tape as supplied shall be of good appearance, free from cracks, and have edges that are true, straight and unbroken. The material shall be available in rolls with no more than 3 splices per 150 feet (45.7 m) of length.

Preformed words and symbols shall conform to the applicable shapes and sizes as outlined in the current "Manual on Uniform Traffic Control Devices for Streets and Highways."

The plastic striping tape shall be packaged in standard commercial containers constructed so as to insure acceptance by the carrier and prevent damage during shipment and storage.

The plastic striping tape as supplied shall be capable of retaining required properties when stored at temperatures up to 100°F (38°C) for periods up to one year.

A Type A certification shall be furnished in accordance with Subsection 106.04.

The plastic striping tape shall conform to the following requirements:

1. *Composition.* The retroreflective, preformed pavement marking film shall consist of high- quality plastic materials, pigments, and glass beads uniformly distributed throughout its cross sectional area and with a retroreflective layer of glass beads firmly bonded on the top surface. The pre-formed plastic film shall be precoated with a pressure- sensitive adhesive which is compatible with bituminous concrete and portland cement concrete road surfaces.
2. *Skid Resistance.* The surface of the retroreflective preformed film shall provide a minimum skid resistance value of 35 British Pendulum Number when tested in accordance with ASTM E 303.
3. *Thickness.* The thickness of the preformed plastic film without adhesive for lane and edge lines shall be not less than 0.060 inch (1.52 mm) and not more than 0.090 inch (2.29 mm).
4. *Tensile Strength and Elongation.* The film shall have a minimum tensile strength of 40 psi (275.8 kPa) of cross section when tested according to ASTM D 638, except that a sample 6 x 1

inch (152.4 x 25.4 mm) shall be tested at a temperature between 70°F and 80°F (21.1°C and 26.7°C) using a jaw speed of 10 to 12 inches (254 to 304.8 mm) per minute. The sample shall have a minimum elongation of 75 percent at break when tested by this method.

5. *Conformability.* The preformed film shall be capable of conforming to pavement contours, breaks and faults through the action of traffic at normal pavement temperatures. The preformed plastic film shall have characteristics such that it is capable of fusing with itself and previously applied marking film of the same composition under normal conditions of use.
6. *Removability.* The plastic striping tape shall be designed so as not to be easily removed after application.
7. *Adhesive.* The plastic striping tape for longitudinal and transverse markings shall have pressure-sensitive backing without liner. Word and symbol tape shall have pressure-sensitive backing with protective liner.
8. *Application Properties.* The material shall adhere to asphalt and concrete surfaces when applied according to manufacturer's recommendations at surface temperature of 65°F (18.3°C) and rising. If the markings must be applied when the surface temperature is below 65°F (18.3°C), but not below 50°F (10°C), the markings are to be applied in strict accordance with the manufacturer's recommended procedures and/or other special instructions.
9. *Glass Beads.* Glass beads shall be incorporated by the manufacturer to provide immediate and continuing retroreflection. The size, quality and refractive index of the glass beads shall be such that the performance requirements for the markings shall be met. The bead adhesion shall be such that beads are not easily removed when the material surface is scratched with a thumbnail.
10. *Pigmentation.* Color pigments shall be thoroughly blended to provide a pavement marking film that maintains uniform color under both daylight and night lighting conditions throughout the expected life of the film. White pavement marking film shall be similar to Federal Standard Color No. 595-17886. Yellow pavement marking film shall be similar to Federal Standard Color No. 595-13538.
11. *Reflectance.* The white and yellow films shall have the following initial minimum reflectance values at 0.2° and 0.5° observation angles and 86.0° entrance angle as measured in accordance with the testing procedures of Federal Test Method Standard 370. The photometric quantity to be measured shall be specific luminance and shall be expressed as millicandelas per square foot per foot-candle [mcd/ft²/fc] (mcd/m²/lux). The test distance shall be 50 feet (15.2 m), and the sample size shall be a 24 inch x 30 inch (610 x 762 mm) rectangle.

The angular aperture of both the photoreceptor and light projector shall be 6 minutes of arc. The reference center shall be the geometric center of the sample and reference center shall be taken perpendicular to the test sample.

	<u>White</u>		<u>Yellow</u>	
Observation Angle, degree	0.2	0.5	0.2	0.5
Specific Luminance, mcd/ft ² /fc (mcd/m ² /lux)	550	380	410	250

12. *Effective Performance Life.* The film, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature if the pavement surface remains stable. The tape must be qualified by a satisfactory performance test of at least 12 months conducted by the Department or an equivalent performance test

conducted by another State Highway or Transportation Department. Although reflectivity is reduced by wear, the pliant polymer shall provide a cushioned, resilient substrate that reduces bead crushing and loss. The film shall be weather resistant and, through normal traffic wear, shall show no appreciable fading, lifting, or shrinkage throughout the useful life of the marking, and shall show no significant tearing, roll back, or other signs of poor adhesion.

711.03. NON-REMOVABLE TEMPORARY PAVEMENT MARKING TAPE.

- (a) **General.** The traffic striping material shall consist of a white or yellow weather and traffic resistant reflective film on a conformable backing precoated with a pressure-sensitive adhesive. A satisfactory performance test of not less than 12 months conducted by the Department or an equivalent performance test by another State Highway or Transportation Department shall qualify the material.

The striping tape shall be white or yellow as specified. The white and yellow striping tape shall be retroreflective, reflecting white or yellow respectively, and shall be readily visible when viewed with automobile headlights at night.

The striping tape shall have a precoated pressure-sensitive adhesive which shall not require a liner for protection from contamination, preadhesion, or blocking within the roll, nor require activation procedures.

The material shall adhere to asphalt and concrete surfaces when applied according to manufacturer's recommendations at surface temperatures down to 35°F (1.7°C) and shall require no protective devices such as traffic cones or barricades.

- (b) **Conformability.** The striping material shall be thin, flexible, and formable, and following application shall remain conformed to the texture of the pavement surface.

The average thickness of the material, as determined by five micrometer readings, will not be less than 15 mils (381 µm) nor more than 45 mils (1143 µm).

- (c) **Durability and Wear Resistance.** The striping material applied in accordance with manufacturer's recommended procedures shall be weather resistant and show no appreciable fading, lifting or shrinkage during the useful life of the line.

- (d) **Packaging.** The striping material shall be packaged in standard commercial containers so constructed as to insure acceptance by the carrier and prevent damage during shipment and storage.

- (e) **Storage.** The striping material as supplied shall be capable of being stored at temperatures up to 100°F (37.8°C) for periods up to one year without deterioration.

- (f) **Certification.** A type D certification shall be required for the non-removable temporary pavement marking tape in accordance with Subsection 106.04.

711.04. REMOVABLE PAVEMENT MARKING TAPE.

- (a) **General.** Removable pavement marking tape shall consist of a white or yellow all-weather traffic-resistant film on a reinforced conformable backing, precoated with a pressure-sensitive adhesive. Glass beads shall be uniformly distributed throughout the film for retroreflectivity.

- (b) **Adhesive.** The removable, preformed pavement marking film shall be precoated with a pressure-sensitive adhesive capable of being adhered to asphalt concrete and portland cement concrete pavement surfaces without the use of heat, solvents, additional adhesives, or activators, and shall be immediately ready for traffic after application. The adhesive shall be capable of bonding to pavement surfaces when applied at temperatures of 50°F (10°C) and above without pickup or distortion by vehicular traffic.

- (c) **Color.** The material shall be white or yellow, as specified, conforming to the standard highway color requirements of the Manual on Uniform Traffic Control Devices.
- (d) **Glass Beads.** The glass beads shall be colorless and shall have a minimum refraction index of 1.50 when tested using the liquid immersion method. The size and quantity of beads shall be such that retroreflectivity of the preformed film is maintained as the film wears through the surface course.
- (e) **Removability.** The preformed pavement marking film shall be removable from asphalt concrete and portland cement concrete pavement intact or in substantially large strips, either manually or by a mechanical roll-up device, at temperatures above 50°F (10°C), and without the use of heat, solvents, grinding or sandblasting.
- (f) **Durability.** The film, when applied according to the recommendations of the manufacturer, shall provide a neat, durable marking that will not flow or distort due to temperature. The tape must be prequalified by a satisfactory performance test of at least 6 months conducted by the Department or by an equivalent performance test conducted by another State Highway or Transportation Department. The removability characteristics must also be demonstrated to meet the requirements of this section through the above described performance test. The film shall be weather resistant and through normal traffic wear shall show no appreciable fading, lifting or shrinkage throughout the useful life of the marking.
- (g) **Certification.** A type D certification shall be required for the removable pavement marking tape in accordance with Subsection 106.04.

711.05. TRAFFIC STRIPE PAINT - TYPE I.

The white and yellow traffic paint shall be suitable for spray application and use as a reflecting traffic guide on concrete and bituminous highway pavements. It is the intent of these Specifications to provide both general and composition requirements in sufficient detail to assure a quality paint capable of providing satisfactory reflectorized traffic lines.

The paint shall be of a type in which the glass beads are dropped on the pigmented binder during application (hereinafter designated as binder type) so that, upon drying, the paint line is capable of retroreflection of the headlight beams from vehicles. The term "paint" is herein construed as pigmented binder.

- (a) **Condition and Stability.** The paint shall be homogeneous, shall be well ground to a uniform and smooth consistency, and shall not skin or settle badly, or cake, liver, thicken, curdle, or gel in the container. The paint shall be capable of being broken up and mixed without difficulty by use of a paddle and shall show the desired characteristics at any time within a period of 6 months from date of delivery.
- (b) **Drying Time.** The paint, when applied to either portland cement concrete or bituminous surfacing at a rate of 15 mil (0.38 mm) thickness (wet film), shall be sufficiently dry within 1/2 hour after application so that there will be no pickup under traffic and shall be thoroughly dry and free from tackiness within 40 minutes after application when the atmospheric temperature is a minimum of 77°F (25°C) and the relative humidity is between 25 and 50 percent.
- (c) **Viscosity.** The paint as received shall have a consistency as determined by the Stormer Viscosimeter at 77°F (25°C) of 68 to 80 Krebs Units (KU). Any paint which changes consistency within 6 months after receipt so that the consistency falls outside the viscosity limits stated above shall be considered to have failed this test.

- (d) **Colors.** The white and yellow colors for traffic marking paint shall conform to the standard high-way color code requirements of the Manual on Uniform Traffic Control Devices for Streets and Highways.
- (e) **Bleeding.** The paint shall not show bleeding sufficient to impair the color and visibility of the paint when applied to a suitably prepared and cured bituminous surface. The pigmented binder shall be tested in accordance with Federal Specification TT-P-85b and shall have a minimum bleeding ratio of 0.95 when tested.
- (f) **Foreign Matter.** The paint shall be free from skins, dirt and other foreign matter, and shall contain not more than one percent water. (Methods 4081, 4091, and 4902.1, Federal Specification TT-P-141a).
- (g) **Composition Requirements and Proportioning.** The various components shall be proportioned by mass as set forth below:

<u>PIGMENTED BINDER</u>	<u>WHITE</u>	<u>YELLOW</u>
	<u>PERCENT</u>	
Pigment, minimum	59.0	55.5
Titanium Dioxide (ASTM D 476 Type III), minimum	18.0	3.2
Medium Chrome Yellow, minimum		14.7
Talc (ASTM D 605), maximum	25.5	42.3
Mica, Water Ground (ASTM D 607), maximum	7.0	
Calcium Carbonate, maximum (Particle size range 0.5-10.0 μm)	49.7	40.7
Vehicle, maximum	41.0	44.5
Medium Oil Alkyd Resin Solids ^a , minimum	37.8	37.9
VM&P Naphtha (IBP 200°F (93.3°C) minimum; DP 290°F (143.3°C), maximum	60.0	59.9
Driers and Additives, maximum	2.8	3.5
Binder Constants:		
Viscosity, 77°F (25°C), KU	68-80	68-80
Fineness, Nominal Size, minimum	2.5	2.5
Dry Time, ASTM D 711, No pick-up, minutes, maximum	40	40
Mass/Unit Volume, 77°F, lb/gal (25°C, kg/l), minimum	12.25 (1.468)	11.80 (1.414)
Skinning, 48 hours, 3/4 full, tightly capped container	None	None
^a Alkyd Resin		
Linseed Oil or Soya Oil, minimum		50
Phthalic Anhydride, minimum		33
Acid Number, minimum		10
Color (G-H), maximum		9
Resin, Phenolic, Petroleum Resins		Negative
Solvent		VM&P Naphtha

- (h) **Containers.** The paint shall be furnished in container size and type as specified in the Contract. Containers shall meet Federal requirements. All containers shall be labeled with the following information:
1. Oklahoma Department of Transportation.
 2. Specification Type.
 3. Purchase Order Number (If applicable).
 4. Manufacturer's Name.
 5. Date of Manufacture.
 6. Manufacturer's Batch Number.
- Labels must be sufficiently weather resistant to withstand outside storage for a minimum of one year.
- (i) **Inspection, Sampling and Testing.** All sampling shall be in accordance with Section 730.
- (j) **Sealed Shipments.** Shipments shall be sealed in accordance with Section 730.

711.06. TRAFFIC STRIPE PAINT - TYPE II.

The high heat white and yellow traffic paint shall be suitable for application by spray equipment when heated from 130°F to 150°F (55°C to 65°C) and applied to bituminous or Portland cement concrete pavements. It shall be capable of receiving and holding glass beads for producing reflectorized traffic markings. High heat traffic paint, as specified herein, shall dry to no pick-up in three (3) minutes.

All materials used in manufacture shall meet the requirements herein specified. Any materials not specifically covered shall meet the approval of the Materials Engineer. The manufacturer shall furnish to the Department the batch formula used to produce the paint.

- (a) **Condition and Stability.** The vehicle and pigment shall be so prepared and blended that the resulting paint shall be uniform in composition and of the required consistency. After storage for periods up to 12 months from the date of packaging, the pigment shall not settle badly or cake in the container, nor shall the paint skin or thicken in storage sufficiently to cause an undesirable change in consistency. The paint, at the time of use, shall comply with all the provisions of these Specifications and be capable of being re-dispersed with a paddle to a smooth uniform condition. Any paint which cannot be remixed to a smooth uniform suspension of useable consistency shall be removed and replaced immediately by the contractor at his expense without additional compensation (including handling and transportation charges).
- (b) **Pigment.**
1. *Medium Chrome Yellow.* This pigment shall comply with ASTM D 211 Type III.
 2. *Titanium Dioxide.* This pigment shall comply with ASTM D 476, Type I, Anatase or Type II, Rutile.
 3. *Aluminum Silicate.* A white pigment that shall consist substantially of anhydrous (calcined) natural aluminum silicate which has been processed to paint pigment quality.
 4. *Magnesium Silicate.* This pigment shall consist substantially of natural hydrous magnesium silicate that is white, fibrous, finely ground, and is commercially known as paint pigment quality.
 5. *Calcium Carbonate.* This pigment shall comply with ASTM Specification D 1199, Type GC, Grade I.
 6. *Anti-Settling (Organo-montmorillonite).* This pigment shall be a finely divided hydrous magnesium aluminum silicate mineral activated with 95% methyl alcohol.

7. *Formulation.*

<u>Pigment Portion</u>	<u>White</u>	<u>Yellow</u>
	<u>PERCENT</u>	
Titanium Dioxide	20-25	--
Medium Chrome Yellow	--	18-23
Aluminum Silicate	28-33	28-33
Magnesium Silicate	16-21	16-21
Calcium Carbonate	20-30	20-30
Bentone 34, Claytone 40 or Tixogel VP	1-2	1-2

No silicas, amorphous or crystalline, shall be permitted.

(c) **Vehicle.**

1. *Alkyd Resin.* The alkyd resin solution shall be a short oil alkyd reduced in toluene to a 59-61% solids content. The solution shall contain a minimum of 41% phthalic anhydride based on the alkyd solids.
2. *Methyl Ethyl Ketone.* This material shall comply with ASTM Specification D 740.
3. *Aliphatic Naphtha.* This material shall meet Federal Specification TT-N-95B.
4. *Toluene.* This material shall comply with ASTM Specification D 362.
5. *Methyl Alcohol.* This material shall be commercial Methyl Alcohol suitable for use in paints.
6. *Drier.* This material shall be lead drier suitable for use in paints.
7. *Anti-Skinning Agent.* This material shall be an anti-skinning agent suitable for use in paints.
8. *Wetting Agent.* Soya lecithin is suitable for use in paint.
9. *Formulation.* This is the Vehicle portion of white and yellow paint.

Alkyd Resin,	63-69%
Solvents, Drier, Wetting Agents,	
Anti-Skinning Agent,	31-37%

(d) **Composition Requirements.**

Pigment by mass, %	50-55
Vehicle by mass, %	45-50
Total non-volatile, %, minimum	70
Vehicle solids/non-volatile vehicle, %, minimum	37
Mass/Unit Volume, lb/gal (Kg/L), minimum	11.90 (1.426)
Viscosity, 77°F (25°C), KU	90-110
Grind (Hegman Gage), minimum	3
Laboratory dry time, ASTM D 711, minutes, maximum	8
Field drying time, minutes	3

- (e) **Field Drying Time.** The reflectorized line, when applied at 15 ± 1 mil (0.38 ± 0.03 mm) wet film thickness and 6 pounds of beads per gallon (0.72 kg of beads per liter) of paint, shall dry to no tracking in 3 minutes or less. The line for the test will be applied with the Department's equipment so as to have the paint at a temperature of 130°F to 150°F (55°C - 65°C) at the spray gun. The 3 minute time shall not be exceeded under any humidity conditions provided that the pavement is dry and the pavement temperature is between 60°F to 120°F (15°C and 50°C). "No tracking in 3 minutes" shall be the time, not to exceed 3 minutes, required for the line to withstand the running of a standard automobile over the line at a speed of approximately 40 mph (65 km/h) simulating a passing procedure without tracking of the reflectorized line when viewed from a distance of 50 feet (15 m).

No allowance for mixing losses will be made in determining percentages of pigment. The mixed paint shall contain the required percentage of pigment upon analysis. Pigments and vehicles extracted from these paints will be subjected to testing by appropriate methods including wet chemical, atomic absorption, X-ray, flame emission, infrared, liquid chromatography, or other available means as may be deemed necessary by the Department to assure compliance with these Specifications.

If outside testing labs are used, the manufacturer will pay the cost of these tests on any batches the Department finds not to be in compliance with these Specifications.

- (f) **Skinning Test.** No skinning shall be present on the surface when the paint is allowed to stand in a partly filled, closed container for 72 hours. The paint shall be free of lumps and skins when strained through a No. 100 (150 μ m) mesh sieve.
- (g) **Bleeding.** The white and yellow pigmented binders shall have a minimum bleeding ratio of 0.95 when tested in accordance with Federal Specification TT-P-85 E (or applicable revision). The asphalt saturated felt shall conform to ASTM Specification D 226 for Type I.
- (h) **Color.** For white, the color after drying shall be a pure flat white, free from tint, furnishing the maximum amount of opacity and visibility under both daylight and artificial light. For yellow, the color after drying shall closely match Chip 33538 of Federal Standard 595. The fixed drying oils used shall be of such character as will not darken under service or impair the color and visibility of the reflectorized line.
- (i) **Contrast Ratio.** The paint shall have a minimum ratio of 0.96 when applied at a wet film thickness of 15 mils (0.38 mm). Apply the wet film, as determined by an Interchemical Wet Film Thickness Gage, to a 2A Leneta Chart or equal. After air drying the paint for 24 hours, measure the luminous reflectance of white and black sections. Contrast Ratio = Black/White.
- (j) **Luminous Reflectance.** The daylight directional reflectance of a dry film white paint (without glass spheres) shall not be less than 80%. The daylight directional reflectance of a dry film of yellow paint (without glass spheres) shall not be less than 54%. A 15 mil (0.38 mm), wet film of paint, as determined by an Interchemical Wet Film Thickness Gage, shall be applied to a form 2A Leneta Chart or equal. After air drying for 24 hours, measure the luminous reflectance of the dry film over a black square using a Hunter or Gardner Tristimulus Colorimeter. Use test method ASTM E-97.
- (k) **Settling.** The pigmented binder in full pint, triple-sealed, friction top, unlined tin cans shall show no dense or hard settling when stored free of vibration at 120°F (50°C) air temperature for five days. At the end of that period, the pigmented binder shall be cooled at room temperature for four hours before making examination. The degree of settling shall have a rating of six or better, when evaluated in accordance with ASTM D 869. In making the tests, place the filled (filled to bottom of the

lip), triple-sealed, friction top, unlined tin can in an inverted position for one hour to insure a complete seal between the cover and body of the can. At the end of one hour, place the filled can in an upright position for at least one hour before placing it in an air temperature of 120°F (50°C). Place the can or cans in a single tier.

- (l) **Containers.** Containers shall meet the requirements of Subsection 711.05(h).
- (m) **Inspection, Sampling, and Testing.** All sampling shall be in accordance with Section 730.
- (n) **Sealed Shipments.** Shipments shall be sealed in accordance with Section 730.

711.07. TRAFFIC STRIPE PAINT - TYPE III (DROP ON).

The white and yellow traffic paints shall conform on a mass basis to the composition of the standard formula as closely as accepted good paint practice will permit. No variation from the standard formula will be permitted, except for replacements of volatiles lost in processing or those approved by the Materials Engineer.

- (a) **Substitutions.** The exact brands and types of raw materials are listed for the purpose of facilitating the selection of parallel material equal not only in quality and composition, but also in physical and chemical behavior after aging in the finished product. Since evaluation of questionable materials may require 60 days after receipt of request from a paint manufacturer, the Contractor is reminded that he should schedule material procurement to permit him to meet delivery commitments. The final decision as to quality of materials shall be made by the Department of Transportation. After the Department of Transportation has approved the brand names of raw materials proposed by paint manufacturer, no substitution will be allowed during manufacture without prior approval of the Department of Transportation.

- (b) **Pigment.**

1. *Pure Titanium Dioxide Rutile, Type II*, shall meet ASTM Specification D 476.
2. *Lead Free Zinc Oxide: American Process, Acicular*, shall meet Federal Specifications TT-P-463a, Type I.
3. *Talc, Paint Grade Magnesium Silicate*, shall meet Federal Specification MIL-M15173, Type B.
4. *Calcium Carbonate:*

CaCO_3	Min. 97 percent
H_2O Max.	0.4 percent
Specific Gravity	2.63 - 2.73
Fineness Requirements	80 percent less than 5 μm
5. *Medium Chrome Yellow ASTM D 211, Type III*.
6. Feldspar, water washed alkali aluminum silicate, Lawson-United LU-340.

Color: Equal to material listed in standard formula. Substitution in a standard formula shall not result in a viscosity greater than 5 KU.

(c) **Resins.**1. *Traffic Paint Alkyd Resin Solution:*1.1 *General:*

- Type: Pure, drying alkyd
 Length: Medium
 Type Oil: Soya, linseed or tall. No mixture of two or more oils will be permitted.
 Solvent: Toluol, ASTM Specification D 362
 Compatibility: A solution of one part 75 percent traffic alkyd and five parts toluol shall be clear.

A solution containing the equivalent of 120 grams of 20 cps chlorinated rubber, 130 grams of 75% traffic alkyd, 200 grams of methyl ethyl ketone shall be clear transparent, and show no separation after 24 hours of storage in a 3/4 full test tube at 80°F±5°F (26.7 ± 2.8°C). This rubber-alkyd solvent solution shall produce a clear film upon drying.

1.2 *Solid Resin Basis:*

Phthalic Anhydrides, %	33 to 37
Percent Oil Acids, %	48 to 55
Acid Number, %, Maximum	8.0
Ash Residue, %, Maximum	0.10
Unsaponifiable, %, Maximum	2.0
Iodine Number of Fatty Acids, Minimum	115
Refractive Index of Fatty Acids, Minimum	1.4660
Rosin based on Fatty Acids, %, Maximum (Tall Oil Alkyds)	1.0

1.3 *45% Solid Basis:*

- Color: Gardner 1953 Standard-9 Maximum
 Drying Time: A wet film 3 mils (76 µm) thick shall set to touch in not more than 90 minutes.
 Dryers: Based on the resin solids present, add the equivalent of 0.06% Cobalt (metal) and 1.0% Lead (metal).
 Toluol shall be used to reduce the resin solution to 45% solids, and shall meet ASTM Specification D 362.

2. *Chlorinated Paraffin:* Shall meet Federal Specification MIL-C-429A, Type I.

3. *Chlorinated Rubber:*

Appearance Free flowing white powder

Viscosity, 20 % W/W in

Toluene (ASTM D 115) 77°F (25°C), Pa·s 0.018 - 0.022

Chlorine, %, minimum

(TT-P-115c 4.3.6) 64.5

Ash, %, maximum 0.20

Solubility: Soluble in aromatic hydrocarbons, eg., toluene, xylene, and alkylated benzenes.

(d) **Thinners:**

- 1.
- Methyl Ethyl Ketone*
- Federal Specification TT-M-26

(e) **Additives:**

- 1.
- Antisettling agent*
- Bentone 34 or Claytone 40

- 2.
- Stabilizer*
- Thermolite 813.

(f) **Composition Requirements.** The various components shall be proportioned by weight (mass) as set forth below:1. *Paint, Traffic:*

	WHITE pounds or kg	YELLOW pounds or kg
Medium Chrome Yellow		85
Titanium Dioxide, Rutile Type II	100	25
Lead Free Zinc Oxide	25	50
Talc	250	100
Feldspar - LU390		125
Calcium Carbonate	275	250
Anti-settling Agent	5	5
Traffic Alkyd 75% solids	130	130
Chlorinated Rubber 20CPS	105	120
Chlorinated Paraffin	85	75
36% Lead Drier	1.5	1.5
12% Cobalt Drier	0.5	0.5
Anti Skinning Agent	2	2
Thermolite 813	0.5	0.5
Methyl Alcohol	5	6
Methyl Ethyl Ketone	207	270
Toluene	53	
Xylene	10	
Total weight, pounds or kg	1254.5	1245.5
Volume, gallons (l)	99.272 (828.46)	98.592 (822.79)
Weight (Mass)/Unit Volume, lb/gal (kg/l)	12.637 (1.5142)	12.633 (1.5138)

2. Properties of Finished Paint:

- 2.1.Weight (Mass)/Unit Volume ± 0.25 lb/gal (± 0.030 kg/l)
of theoretical
- 2.2.Consistency (Krebs-Stormer), KU, 77°F (25°C) 75-85
- 2.3.Drying Time (ASTM D711), maximum, minutes 5
- 2.4.Bleeding (Fed. Spec TT-P-85d 4.3.11), minimum 0.95
- 2.5.Dry Opacity (Fed. Test Std. No. 141a
Method 4121 using wet film of approximately
4 mils (101.6 μ m)), minimum 0.91
- 2.6.Daylight Reflectance
(Fed. Test Std. No. 141 Method 6121), % White, 80 Yellow, 50
- 2.7.Fineness of grind (Hegman), minimum 3
- 2.8.Skinning, 48 hours, 3/4 filled tightly closed can None
- 2.9.Color: Yellow dry film shall be in compliance with "Highway Yellow Color Chart"
U.S. Dept. of Transportation, Federal Highway Administration.

(g) Composition Requirements:

	<u>WHITE</u>	<u>YELLOW</u>
Total Solids, %	75.0 ± 2	74.5 ± 2
Pigment, %	52.2 ± 2	51.4 ± 2
Vehicle, %	47.8 ± 2	48.6 ± 2
Non-volatile Material (Vehicle), %, minimum	45.5	45.5

Upon chemical analysis of pigments and vehicle solids, the percentages must be within reasonable manufacturing tolerances as determined by the Department of Transportation.

- (h) **Containers.** Containers shall meet the requirements of Subsection 711.05(h).
- (i) **Inspection, Sampling, and Testing.** All sampling shall be in accordance with Section 730.
- (j) **Sealed Shipments.** Shipments shall be sealed in accordance with Section 730.

711.08. TRAFFIC STRIPE PAINT - TYPE IV (DROP-ON).

The white and yellow traffic paints shall conform on a mass basis to the composition of the standard formula as closely as accepted good paint practice will permit. No variations from the standard formula will be permitted, except for replacement of volatiles lost in processing, or those approved by the Materials Engineer.

- (a) **Substitutions.** The exact brands and types of raw materials are listed for the purpose of facilitating the selection of parallel materials equal not only in quality and composition, but also in physical and chemical behavior after aging in the finished product. Since evaluation of substituted materials may require up to sixty days, the Contractor is reminded to schedule material procurement to permit him to meet delivery commitments. The final decision as to quality of materials shall be made by the Department of Transportation. After the Department of Transportation has approved the brand names

of raw materials proposed by paint manufacturer, no substitution will be allowed during manufacturing without prior approval of the Department of Transportation.

(b) **Pigment.**

1. **Pure Titanium Dioxide Rutile, Type II;** shall meet ASTM Specification D 476-73.
2. **Lead Free Zinc Oxide:** American Process, Acicular, shall meet Federal Specification TT-P-463a, Type I.
3. **Talc, Paint Grade Magnesium Silicate;** shall meet Federal Specification MIL-M15173, Type B.
4. **Calcium Carbonate:**

CaCO_3	Min. 97 percent
H_2O	Max. 0.4 percent
Specific Gravity	2.63 - 2.73
Fineness Requirements:	80% less than 5 μm

Color: Equal to material listed in Standard Formula. Substitution in a Standard Formula shall not result in viscosity variation greater than 5 KU.

5. **Medium Chrome Yellow ASTM D 211, Type III.**
6. **Feldspar,** water washed alkali aluminum silicate, Lawson-United LU-340.

(c) **Resins.**

1. **Traffic Paint Alkyd Resin Solution:**

1.1 **General:**

Type: Pure, drying alkyd
 Length: Medium
 Type Oil: Soya, linseed or tall. No mixture of two or more oils will be permitted.
 Solvent: Toluol, ASTM Specification D 362

Compatibility: A solution of one part 75% traffic alkyd and five parts toluol shall be clear.

A solution containing the equivalent of 125 grams hypalon, 144 grams of 75% traffic alkyd, 200 grams of methyl ethyl ketone shall be clear, transparent, and show no separation after 24 hours of storage in a 3/4-full test tube at $80^\circ\text{F} \pm 5^\circ\text{F}$ ($26.7^\circ\text{C} \pm 2.8^\circ\text{C}$). This rubber-alkyd-solvent solution shall produce a clear film upon drying.

1.2 **Solid Resin Basis:**

Phthalic Anhydrides, %	33 to 37
Oil Acids, %	48 to 55
Acid Number, %, Maximum	8.0
Ash Residue, %, Maximum	0.10
Unsaponifiable, %, Maximum	2.0
Iodine Number of Fatty Acids, Minimum	115
Refractive Index of Fatty Acids, Minimum	1.4660
Rosin based on Fatty Acids	
(Tall Oil Alkyds), %, Maximum	1.0

1.3 **45% Solids Basis:**

Color: Gardner 1953 Standard - 9 max.
 Drying Time: A wet film 3 mil (0.076 mm) thick shall set to touch in not more than 90 minutes.
 Driers: Based on the resin solids present, add the equivalent of 0.06% Cobalt (metal) and 1.0% Lead (metal).

Toluol shall be used to reduce the resin solution to 45% solids, and shall meet ASTM Specification D 362.

2. **Chlorinated Paraffin:** Shall meet Federal Specification MIL-C-429A, Type I.

3. **Hypalon Resin:**

Appearance: Free flowing white powder

Viscosity (20% W/W in Toluene

ASTM-D-115), 25°C, Pa·s 0.018 - 0.022

Chlorine, (TT-P-115c4.3.6), %, minimum 64.5

Ash, %, maximum 0.20

Solubility: Soluble in aromatic hydrocarbons eg., toluene, xylene, and alkylated benzenes

- (d) **Thinners.**

1. Methyl Ethyl Ketone Federal Specification TT-M-26

- (e) **Additives.**

1. Antisettling agent Bentone 34 or Claytone 40
2. Stabilizer Thermolite 813

- (f) **Composition Requirements.** The various components shall be proportioned by weight (mass) as set forth below:

1. **Paint, Traffic**

	WHITE	YELLOW
	<u>pounds or kg</u>	<u>pounds or kg</u>
Medium Chrome Yellow		85
Titanium Dioxide, Rutile Type II	100	25
Lead Free Zinc Oxide	25	50
Talc	350	300
Feldspar - LU390		175
Calcium Carbonate	175	
Anti-settling Agent	5	5
Traffic Alkyd 75% solids	144	144
Hypalon	125	125
Chlorinated Paraffin	25	25
36% Lead Drier	2.0	2.0
12% Cobalt Drier	1.0	1.0
Anti-skinning Agent	2.0	2.0
Thermolite 813	0.5	0.5
Methyl Alcohol	5	6
Methyl Ethyl Ketone	200	200
Aliphatic Naphtha (TTN-95)	83	83
Soya Lecithin	8	8
Total weight, pounds (Mass, Kg)	1250.5	1236.5
Volume, gallons (L)	102.46 (855.1)	101.44 (846.56)
Mass/Unit Volume, 16/gal (Kg/L)	12.204 (1.4624)	12.189 (1.4606)

2. **Properties of Finished Paint:**

2.1.Weight (Mass)/Unit Volume	±0.25 lb/gal (± 0.030 Kg/L) of theoretical
2.2.Consistency (Krebs-Stormer), KU, 77°F (25°C)	80-90
2.3.Drying Time (ASTM D711), maximum, minutes	7
2.4.Bleeding (Fed. Spec TT-P-85d 4.3.11), minimum	0.95
2.5.Dry Opacity (Fed. Test Std. No. 141a Method 4121 using wet film of approximately 4 mils (101.6 µm)), minimum	0.91
2.6.Daylight Reflectance (Fed. Test Std. No. 141a Method 6121), %	White, 80 Yellow, 50
2.7.Fineness of grind (Hegman), minimum	3
2.8.Skinning, 48 hours, 3/4 filled tightly closed container	None
2.9.Color: Yellow dry film shall be in compliance with "Highway Yellow Color Chart" U.S. Dept. of Transportation, Federal Highway Administration.	

3. **Composition Requirements:**

	<u>WHITE</u>	<u>YELLOW</u>
Total Solids, %	73.5 ± 2	73.5 ± 2
Pigment, %	52.2 ± 2	51.4 ± 2
Vehicle, %	47.8 ± 2	48.6 ± 2
Non-volatile Material(Vehicle), %, minimum	43.5	43.5

Upon chemical analysis of pigments and vehicle solids, the percentages must be within reasonable manufacturing tolerances as determined by the Department of Transportation.

- (g) **Containers.** Containers shall meet the requirements of Subsection 711.05(h).
- (h) **Inspection, Sampling, and Testing.** All sampling shall be in accordance with Section 730.
- (i) **Sealed Shipments.** Shipments shall be sealed in accordance with Section 730.

711.09. GLASS BEADS FOR TRAFFIC PAINT.

Glass beads used for thermoplastic compound and traffic stripe paint shall meet the requirements of AASHTO M 247, Type I. Beads shall be supplied with a moisture- resistant coating.

711.10. TRAFFIC STRIPE PAINT - ACRYLIC WATERBORNE.

These Specifications cover waterborne white and yellow traffic paint for application directly onto bituminous or Portland cement concrete pavements or existing traffic stripe composed of solvent based paint, waterborne paint, or thermoplastic compounds. Application will be made by spray equipment at application temperatures of 50°F to 150°F (10°C to 66°C). The paint shall be capable of receiving and holding glass beads for producing reflectorized traffic markings.

- (a) **Materials.** The paint shall contain no lead and/or chromium and shall have limited Volatile Organic Content (VOC), as noted herein.
- (b) **General.** The finished paint shall be formulated and manufactured from first-grade material. The materials shall be as listed in the Standard Formula, unless otherwise authorized in advance of manufacture by the Engineer. Any proposed equivalent materials shall equal or exceed the quality and composition and the physical and chemical behavior of the specified material after aging in the finished product.
- (c) **Pigment.**
 - 1. **Titanium Dioxide.** This material shall comply with the latest revision of the Specification for Titanium Dioxide Pigments, ASTM D 476, type II, Rutile. Hiding power of the titanium dioxide shall be greater than or equal to the standard sample when tested in the standard formula.
 - 2. **Pigment Yellow 65.** This material will only be allowed from the following sources unless otherwise approved by the Materials Engineer: Hoechst Celanese, Engelhard, and Sun Chemical.
 - 3. **Calcium Carbonate.** This material shall comply with the latest revision of the Specification for Calcium Carbonate Pigments, ASTM D 1199, Type GC, Grade I, with minimum of 95% Calcium Carbonate and Type PC, minimum 98% Calcium Carbonate.
- (d) **Vehicle.**
 - 1. **Acrylic Emulsion Polymer.** The nonvolatile portion of the vehicle shall be composed of a 100% acrylic polymer and shall not be less than 44% by mass. Acrylic emulsion polymer shall be Rohm and Haas E-3427 or equal as determined by the Materials Engineer.
 - 2. **Methyl Alcohol.** ASTM D 1152 Specific Gravity, 20/20° C, 0.791 to 0.794.
 - 3. **Water.** Potable.
 - 4. **Miscellaneous Materials.**
 - 4.1. **Dispersant.** Tamol 850, Colloids 226-35.
 - 4.2. **Surfactant.** Triton CF-10, Colloids CTA 639.
 - 4.3. **Defoamer.** Foamaster 111, Drew 493 Colloids 654.
 - 4.4. **Hydroxy Ethyl Cellulose.** Natrasol 250 HBR, Bermocoll E431FQ.
 - 4.5. **Coalescent.** Texanol.
 - 4.6. **Preservative.** Troy 192, Dowicil 75, Nuosept 101.
- (e) **Manufacture.**
 - 1. All ingredient materials shall be delivered in the original containers and shall be used without adulteration.
 - 2. The manufacturer shall furnish to the Department the exact batch formula which will be used in manufacturing the paint. No change shall be made in this formula without prior approval by the Department, and no change will be approved that adversely affects the quality or serviceability of the paint.
 - 3. The following Standard Formulas shall be the basis for the paint. No variations will be permitted except for the replacement of volatiles lost in processing, or those approved by the Engineer. Amounts are shown in pounds (kilograms) of material.

	<u>WHITE</u>	<u>YELLOW</u>
C.I. Pigment, Yellow 65 (Engelhard 1244)	-	32 (14.5)
Titanium Dioxide, Rutile, Type II (Kerr McGee CR800)	100 (45.4)	21 (9.5)
Calcium Carbonate, Type PC (Miss. M-60)	150 (68.0)	150 (68.0)
Calcium Carbonate, Type GC (Hubercarb Q6)	430 (195.0)	465 (210.9)
Hydroxy Ethyl Cellulose (Natrasol 250HBR)	0.5 ^a (0.2 ^a)	0.5 ^a (0.2 ^a)
Acrylic Emulsion, 50% Solids (E2706)	541 (245.4)	535 (242.7)
Texanol (Eastman)	24 (10.9)	23 (10.4)
Defoamer (Colloids 654)	5 (2.3)	5 (2.3)
Dispersant (Tamol 850)	8 (3.6)	9 (4.1)
Surfactant (Triton CF10)	2 (0.9)	2 (0.9)
Methyl Alcohol	29 (13.2)	28 (12.7)
Preservative (Troy 192)	1.5 (0.7)	1.5 (0.7)
Water	<u>10. (4.5)</u>	<u>10. (4.5)</u>
TOTAL POUNDS (KILOGRAMS)	1301 (590.1)	1282 (581.8)

^a Hydroxy Ethyl Cellulose amount may be varied by up to 1 pound (0.05 kg) to adjust viscosity to desired range.

(f) **Mixed Paint.** The mixed paint shall conform to the following requirements. Furthermore, if any variations in materials are allowed from the Standard Formula, the mixed paint shall equal or exceed all test results on a standard prepared from the Standard Formula and tested by the manufacturer under parallel conditions for all the listed requirements.

1. The paint shall be strained before filling, using a screen not coarser than No. 40 mesh (425µm) or a suitable sieve meeting the approval of the Engineer.
2. The volatile content of the finished paint shall contain less than 1.25 pounds (150 grams) of volatile organic matter per gallon (liter) of total non-volatile paint material in accordance with ASTM D 3960.
3. The paint shall have the following properties:
 - 3.1. **Pigment Composition.** Analysis of the extracted pigment shall conform to the following requirements:

	<u>WHITE</u>	<u>YELLOW</u>
Organic Yellow (65%)	-	Min. 4.8 ^a
Titanium Dioxide (%)	Min. 13.4	Min. 2.6
Calcium Carbonate (%)	Max. 86	Max. 93

^a To be determined by x-ray florescence, color spectrophotometry, or any other method the Department may choose. This may be sent to an outside agency or organic pigment manufacturer. It also may include audit of the manufacturer's invoices, batch tickets, inventory or any other means determined by the Department.

3.2. **Physical Properties.**

% Total Solids by mass, minimum	73
% Volume Solids, minimum	58
% Pigment by mass	49-54
% Vehicle by mass	46-51
% Non-volatile in Vehicle by mass, minimum	44
Theoretical weight (mass) per unit volume	± 0.3 lb/gal (± 36 g/liter)
Viscosity, 77°F (25°C), Krebs Unit	83-98
Grind (Hegman Gage), minimum	3
Laboratory Dry Time, ASTM D 711, minutes, maximum	10
Dry Through	Not greater than 15 minutes of Standard Formula

3.3. **Color.** The color of the white paint after drying shall be a flat white, free from tint, furnishing good opacity and visibility under both daylight and artificial light.

For yellow, the color shall closely match Color Chip 33538 of Federal Standard 595 and be $\pm 6\%$ from the PR 1 chart central color when read over the black portion of a 2A Leneta Chart.

3.4. **Flexibility.** The paint shall show no cracking or flaking when tested in accordance with Federal Specification TT-P-1952B.

3.5. **Water Resistance.** The paint shall conform to Federal Specification TT-P-1952B. There shall be no blistering or appreciable loss of adhesion, softening, or other deterioration after examination.

3.6. **Freeze-Thaw Stability.** The paint shall show no coagulation, discoloration, or change in consistency greater than 10 Krebs Units, when tested in accordance with Federal Specification TT-P-1952B.

3.7. **Heat Stability.** The paint shall show no coagulation, discoloration, or change in consistency greater than 10 Krebs Units, when tested in accordance with Federal Specification TT-P-1952B.

3.8. **Dilution Test.** The paint shall be capable of dilution with water at levels without curdling or precipitation such that the wet paint can be readily cleaned up with water only.

3.9. **Storage Stability.** After thirty (30) days of storage in a three-quarters ($\frac{3}{4}$) filled, closed container, the paint shall show no caking that cannot be readily remixed to a smooth, homogeneous state, no skinning, livering, curdling or hard settling. The viscosity shall not change more than 5 Krebs Units from the viscosity of the original sample. After storage for periods of up to nine (9) months from the date of packaging, the pigment shall not settle badly or cake in the container, nor shall the paint skin or thicken in storage sufficiently to cause an undesirable change in consistency, nor show spoilage. The paint shall comply with all the provisions of these Specifications and be capable of

being re-dispersed with a paddle to a smooth, homogeneous condition of useable consistency.

- 3.10. **Contrast Ratio.** The minimum contrast ratio shall be 0.98 when applied at a wet film thickness of 15 mil (381 μm) on a 2A Leneta Chart or equal and air dried for 24 hours. Contrast Ratio = Black/ White.
- 3.11. **Reflectance.** The daylight directional reflectance of the white paint shall not be less than 84% and not less than 50% for yellow paint of a 15 mil (381 μm) wet film applied to a 2A Leneta Chart or equal. After it has dried for 24 hours, measure the reflectance of the paint over the black portion of the chart using a Colorimeter and test method ASTM E 97.
- 3.12. **Bleeding.** The paint shall have a minimum bleeding ratio of 0.97 when tested in accordance with Federal Specifications TT-P-1952B. The asphalt- saturated felt shall conform to ASTM D 226 for Type I.
- 3.13. **Abrasion Resistance.** No less than 50 gallons (190 liters) of sand shall be required for removal of the paint film when tested in accordance with Federal Specification TT-P-1952B.
- 3.14. **No-Tracking Time Field Test.** The paint shall dry to a no-tracking condition under traffic in three minutes maximum when applied at 17 mils \pm 1 mil (432 \pm 25 μm) wet film thickness plus 45 pounds of glass beads per cubic foot (719 kilogram of glass beads per cubic meter) of paint under conditions specified in these Specifications. "No tracking" shall mean the line has dried to the point where a standard automobile can run over the line at 40 mph (64 km/hr) while making a passing movement and not track the reflectorized line when viewed from a distance of 50 feet (15 meter).
- 3.15. **Dry Through Time.** The paint shall be applied to a non-absorbent substrate at a wet film thickness of 17 mils \pm 1 mil (432 μm \pm 25 μm) and placed in a humidity chamber controlled at 90 \pm 5% R.H. and 72.5°F to 2.5°F (22.5°C \pm 1.4°C).

The dry through time shall be determined according to ASTM D 1640, except that the pressure exerted shall be the minimum needed to maintain contact with the thumb and film.

- (g) **Containers.** Containers shall meet the requirements of Subsection 711.05(h).
- (h) **Inspection, Sampling and Testing.** All sampling shall be in accordance with Section 730.
- (i) **Sealed Shipments.** Shipments shall be sealed in accordance with Section 730.